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Making space law relevant to basic space science in the commercial space age

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Abstract

Space science has been at the heart of humanity's activity in space, a fact reflected in the body of space law set up to regulate such activity. The increase in commercial utilisation of space may threaten the conduct of space science; reform of space law, however, could alleviate this situation. Using the examples of radio and light interference, and space debris, this articles examines ways in which the law could be reformed to improve conditions for scientists. It also discusses the need for, and equitable ways of, prioritising space activities. The forthcoming IHY 2007 should provide an opportunity for scientists to showcase their achievements.

1. Introduction

Space science was at the origin of humankind's drive into space. From the very beginning of the Space Age the scientific benefits to be accrued through the exploration and use of outer space have been among the main justifications for the huge investments made by states [1]. The International Astronautical Federation (IAF) has been vocal in its support for space satellites since its founding in 1951. The International Geophysical Year (IGY) of 1957 led to the development of the USA space satellite programme [2], the establishment of the National Aeronautics and Space Administration (NASA), and the United Nations Committee for the Peaceful Uses of Outer Space (COPUOS) [3]. It was also a major catalyst behind the launch of Sputnik I. Space science has continued to be for many countries the initial point of contact with space activities [4, p. 2].

It is therefore unsurprising that the rules established by the international community to regulate space activities at the beginning of the space age—compendiously referred to as space law—also reflect the importance of basic space science. It was a scientific achievement—the first successful 'soft' landing on the Moon by the former Soviet Union's Luna IX module—that provided a major impetus for progress in drafting space law principles [5, p. 156]. As it became clear that a manned Moon landing was inevitable, the international community—in particular the two space powers at that time—became eager to further refine these principles through the conclusion of a legally binding instrument [5, p. 216].

The result was the Outer Space Treaty of 1967, which is the main international instrument regulating states' space activities. Importantly for space scientists, article 1 of the Outer Space Treaty declares the principle of 'freedom of scientific investigation in outer space', and encourages States to 'facilitate and encourage international cooperation in such investigation'.

However, in recent times, much more attention has been focused on the commercial utilisation of outer space. The potential for destructive interference with the conduct of space science is high. Scientists are being challenged to find ways to co-exist alongside commercial space activities. This article examines the extent to which scientists can look to space law principles to protect their interests in the commercial space age. It will be argued that although space science has historically occupied a central role in the development of space law, directly enforcing legal principles to protect space science has proven problematic. Scientists need to agitate for reform not only to address the specific issues which are immediately threatening the conduct of space science, but also to address the chronic

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problem by clarifying and strengthening the existing space law principles that relate to science.

2. The process of drafting and reforming space law

The area of space law is a paradigm example of legal drafting through international consultation. The United Nations has established itself as the central forum for consultations between states and the key mechanism for achieving legal reform.

The primary body for all space-related programmes undertaken by the United Nations is the Committee for the Peaceful Uses of Outer Space (COPUOS). It currently has 67 member states, and consists of two subsidiary bodies: the Legal Subcommittee (LSC) and the Scientific and Technical Subcommittee (STSC).

The operation of COPUOS is typical of a United Nations body. First, the STSC meets every year for two weeks in February to discuss scientific issues and develop technical expertise. On the basis of these deliberations, the LSC meets in March/April to develop suggestions for regulatory reform. Finally, the whole Committee meets in June to consider the work of the Subcommittees and to adopt resolutions if required. In theory, this produces a conveyor-belt approach to law reform, beginning with specialist discussion in the technical forum, leading to legal drafting, which is then adopted according to political exigencies in the full Committee [4, p. 1].

An important aspect of the working methods of COPUOS and its Subcommittees is the consensus principle. All decisions are made with the agreement of all parties present,[1] which increases the legitimacy of the decision-making process. Of course, this also means that deliberations may take a long time to reach the necessary compromise. The consensus principle has been followed since the founding of COPUOS and there is no indication that it will be changed in the near future.

While COPUOS constitutes the main formal decision-making mechanism, other processes also play an important part. For example, informal discussions take place before and during the sessions. These may be multilateral discussions among delegations with common interests or views. A number of specialist scientific bodies, such as the International Astronomical Union (IAU), also enjoy observer status with COPUOS, and are regularly invited to make submissions on topics of particular interest to space scientists (generally at the STSC).[2] Finally, the United Nations has convened three conferences on the Exploration and Peaceful Uses of Outer Space (Unispace conferences), open to all UN member states, which review progress in space activities and set down high-level policy objectives towards which for future sessions of COPUOS to strive towards. The last such conference (Unispace III), held in 1999, adopted the 'Vienna Declaration on Space and Human Development', focusing on the potential of space applications to benefit human security, development and welfare. Those interested in achieving space law reform need to appreciate the importance of these mechanisms.

3. Future legal challenges for astronomy and basic space science—preservation of the space environment

The nature of space activity has changed drastically since the launch of Sputnik I in 1957. When the basic principles of space law were drafted in the 1960s, outer space was solely the playground of states. The Outer Space Treaty makes no provision for private commercial operators; they are only regulated to the extent that states are held liable (under arts 6 and 7) for national activities in outer space, whether such activities are carried out by governmental or non-governmental agencies. Today, private operators are now highly active in the telecommunications, remote sensing and space manufacturing industries. Between 1996 and 2000, private sector spending on telecommunications satellites alone was estimated to total USA$54.3 billion, with an additional $70 billion invested in satellite ground stations [7, p. 59].

While the dramatic increase in space utilisation has undoubtedly brought about significant improvements in space technologies, it has also begun to adversely affect the work of space scientists. Astronomical observation requires fine precision and favourable conditions, and is particularly sensitive to interference from other users. Where the interests of science and commerce are incompatible, scientists are generally ill-equipped to defend themselves against the economic might of commercial actors. Naturally, stakeholders in commercial space satellites demand a return on their huge investments, even where this has the potential to affect other space actors. Scientists have to look to rules, agreed to by the international community, that recognise the role of basic space science and guarantee its continued existence.

In this section, two particular issues relevant to space science will be examined. They have been selected because they have been the subject of recent discussion in relation to possible regulatory reform.

3.1. Radio/light interference

A major problem for ground-based astronomers is the increasing level of interference occurring from space-related activities. Given that telescopes and detectors are now investigating objects 100 million times fainter than those visible with the naked eye [5,6], and radio telescopes are studying similarly weak transmissions, it is obvious that the increased amount of space traffic, and above all the radiation transmitted from this traffic, could have a devastating impact on astronomy. Persistent lobbying

[1] Cf. Bin Cheng who frames the principle in the negative; according to him, consensus means that 'no decision will be taken against the strong objection of any member';Ref. [5, p. 164].

[2] See, eg. the background paper submitted by the IAU on the topic of obtrusive space advertising; Reference [6].

from expert groups such as the IAU has succeeded in bringing this problem to the attention of the international community [8]. Most notably, the Unispace III conference declared that 'attention should be given to preserving or restoring astronomical observation conditions to a state as close to natural as possible by any practicable means' [9].

In terms of light pollution, a major (space-based) threat to astronomy comes from projects to insert 'space advertising' material into orbit. For example, the IAU documents a 1996 proposal from a USA-based firm to unfurl a 1 km^2 'Space Billboard' that would have rivalled the full Moon in size and brightness [6, UNDOC No. A/AC. 105/777, [16]]. Had the project come to fruition, it would have effectively destroyed any possibility for observation in that broad area of the night sky.

3.1.1. Proposals for reform

There is a lack of clear regulation in the area of 'space advertising' which may be endangering the future of ground-based astronomy. The IAU has proposed a ban on 'obtrusive space advertising', identifying two main characteristics of such objects. A project may be deemed as 'advertising' if it is without 'factual scientific or technical function', and/or where the revenues gained flow only to the originators. This would avoid genuine scientific missions from being prohibited, even though they are obtrusive in the astronomical sense (for example ISS). In determining the extent of obtrusiveness, the IAU names brightness, visibility period and extent of illumination as three critical criteria. It is interesting to note that the USA has already prohibited the issuing of launch licenses for 'obtrusive space advertising', which it defines as 'advertising in outer space that is capable of being recognized by a human being on the surface of the Earth without the aid of a telescope or other technological device' [10]. The USA Federal Aviation Authority has recently proposed amending its regulations to provide for the mandatory review of proposed payloads to see if they amount to 'obtrusive space advertising' [11].

The IAU's proposal was considered by COPUOS and its Scientific and Technical Subcommittee in 2002. The Subcommittee agreed that space advertising poses a 'grave concern for the future' [12, UNDOC A/AC. 105/786, [140]] and 'noted with appreciation' the preventative legislative efforts of the USA. However, despite this and the recommendation from Unispace III, COPUOS fell short of endorsing legal change and the item 'space advertising' was removed from the agenda thereafter. Hence there is no comprehensive international prohibition on space advertising of the sort discussed. It remains a matter to be determined by individual countries.

The huge increase in telecommunications satellites is also threatening the future of radio astronomy. These satellite transponders broadcast signals millions of times stronger than the faint cosmic whispers received by radio telescopes. To put into context the difference in magnitude, the IAU points out that if a single mobile phone were placed on the moon, it would be among the four brightest sources in the radio sky [6,8]. The strength of the transmissions currently being sent by communications satellites is such that 'spillover' into adjacent frequency bands is inevitable and growing enormously [13].

The current regulatory framework governing electromagnetic transmission in the radio range is largely set down by the International Telecommunication Union (ITU) in its Radio Regulations. The ITU coordinates the use of the radio spectrum, dividing bandwidth and frequencies between countries for various communications uses [14]. In the past, radio astronomers were granted exclusive or priority usage over certain frequency bands of particular scientific interest. Furthermore, scientists were formerly able to place their observatories in largely uninhabited, 'radio-quiet' areas where the prospect of interference was not so great. However, with the global coverage of telecommunication satellites, problems of 'spillover' and non-compliance, the fragile status-quo situation no longer seems sustainable.

Among the solutions that have been put forward, the most interesting from a legal standpoint is the introduction of a system of 'radio quiet zones' (RQZs). The RQZs would be designated areas of the Earth where satellite communications signals would be kept to tolerable levels, compatible with radio astronomy observations [13, p. 266]. Such an approach would require a large amount of international cooperation and regulation, quite possibly involving the drafting of a new treaty or protocol. It has been pointed out that the ITU at present lacks the jurisdiction to implement such a proposal [13, p. 272]. The regulatory alternative would be to strengthen the current system and possibly introduce a frequency-sharing scheme with other services (since radio astronomers do not require temporal exclusivity).

Further investigation into the establishment of RQZs was encouraged by the 1999 Technical Forum 'Preserving the Astronomical Sky', conducted in the run-up to Unispace III. The Workshop on Space Law in the Twenty-First Century recommended that legal action be taken to reserve radio bands for astronomy and to protect it from the problem of 'spill-over'. Finally, as part of 'The Space Millennium: Vienna Declaration on Space and Human Development', Unispace III itself adopted a recommendation that:

> All users of space [should] consider the possible consequences of their activities, whether ongoing or planned, before further irreversible actions are taken affecting future utilization of near-Earth space or outer space, especially in areas such as astronomy…[9, p. 3].

To date, this statement has not led to substantive legal change; however, it is clearly a topic that requires action, and the Unispace III declaration, as an expression of policy accepted by all participating states, provides an impetus for future progress.

3.2. Space debris

Also of global concern to astronomers and space scientists is the growth in what is commonly known as 'space debris', that is, objects in Earth orbit that do not serve a functional purpose. According to some estimates, 95% of all man-made objects currently in outer space can be classified as 'space debris' [15, p. 212, 213]. These objects range from sub-millimetres to metres in diameter, are difficult to detect and can have impact velocity on collision of up to 15 km/s [16]. At such speeds, studies show that an impacting particle of 1 g mass compares by approximation with the explosive energy of 10 g of dynamite [16, p. 100].

Space debris is of concern to space scientists for two reasons. First, the proliferation of objects in the sky can adversely affect ground-based astronomical observations, which depend on extremely high sensitivity and resolution. If an object passes through the field of view of a space telescope during exposure, this can degrade both photographic and photometric studies [9, p. 29]. and intensely bright space debris objects can even cause physical damage to sensitive equipment [17]. Second, space debris threatens space-based observatories, since the consequences of the impact of even a small particle of space debris could be catastrophic for such satellites. Indeed, in 1996 the French CERISE spacecraft was struck and partially disabled by the impact of a fragment of an exploded Ariane upper stage [18].

Most commentators agree that the issue of space debris requires immediate action. According to one simulation, if space operators simply continue to operate as they do currently, the growth in debris will be such that spaceflight in near-Earth orbit will be paralysed within 100 years [16, p. 101]. The risk of collision and destruction of satellites launched would simply be too large. Indeed, even a complete and immediate cessation of space activities would not reduce the amount of debris currently in orbit, because of the collisions that will statistically take place between objects already present, which in turn will produce more debris (a self-sustaining chain reaction). Moreover, this overcrowding is permanent. It will be most difficult, if not impossible, to construct a device to clean up the low-Earth orbit.[3] Therefore, it is imperative to take measures now to halt the build-up of debris.

Currently there is no comprehensive legal framework dealing with the issue of space debris. Articles VI–IX of the Outer Space Treaty, along with the Liability and Registration Conventions do establish a regime of consultation, registration, international responsibility and liability for damage caused by objects (which includes component parts of such objects) launched into space. However, the imposition-of-liability approach to encouraging prudent behaviour does not function as effectively in zero-gravity as on Earth.

First, it is almost impossible to track the origin of small pieces of debris, which may be second- or third-generation fragments from a series of explosions. In the case of collision, the chances of being able to identify the state responsible for the emission of debris are remote.

Second, even assuming the damage-causing debris can be traced, several commentators have pointed out that it is unclear how space debris damage would be treated under the Outer Space Treaty and Liability Convention. In the case of damage caused by the 'space object' of one state to persons or property of another state other than on the Earth's surface, in order to establish liability under the Liability Convention, there is a requirement to prove 'fault' on the part of the launching state [20]. On one reading, the concept of 'fault' could simply mean that the space debris, as opposed to the space object being crashed into, was 'responsible' for the crash. That would mean that if space debris hit another space object, the launching state producing the debris would be responsible unless it was a distinct change of trajectory of the other space object which made it crash into the space debris. However, on another plausible reading, the concept of 'fault' involves more than the mere production of debris as a result of legitimate space operations [19, p. 46]. This suggests that a claimant state would have to establish some sort of negligence on the part of the debris-producing state, which would lead to debate over difficult issues of foreseeability and reasonableness [19].

Although it is in the interests of all spacefaring nations to limit the amount of space debris, the current regime with its imposition of fault-based liability alone seems insufficient as an incentive for states to take decisive action.

3.2.1. Proposals for reform

Various international technical and legal bodies have been investigating the issue of space debris over the past 10–15 years.

From the technical perspective the item 'space debris' first appeared on the agenda of the STSC of COPUOS in 1994, and has been the subject of two consecutive four-year working plans. To date the outcome of this deliberation has been the production of a Technical Report (in 1999), which provided an understanding of the debris environment, assessed risks and analysed debris mitigation measures being undertaken by various operators [21]. Then, in 2003, the Inter-Agency Space Debris Coordination Committee (IADC), an international forum of national and regional space agencies, developed a set of Mitigation Guidelines to reduce space debris emissions. In 2005, the STSC resolved to create a concise space debris mitigation document based on the IADC report, providing high-level qualitative guidance to states, but being recommendatory in nature [22].

The IADC Mitigation Guidelines include two main aspects. First, orbital explosions of satellites (both during

[3]Reference [16]. This is not to mention the legal issues that would be involved in destroying or removing space debris owned by another State; see [19].

and post-mission) should be avoided through venting of residual fuel, discharging of batteries and depletion of flywheels and momentum wheels. Second, satellites in near-Earth orbit should be de-orbited after their functional lifetimes, preferably crashed directly into an ocean or at least manoeuvred into an orbit from which natural atmospheric drag will bring the object out of orbit. Of course, care must be taken during such an operation to avoid debris reaching the Earth's surface, unduly posing a threat to people or property.

According to estimates, the cost of mitigation measures may add 15–20% to the cost of launching a space object. Given the growing commercialisation and competition in space activities, operators will be reluctant voluntarily to assume such costs unless they are made mandatory for all competitors.[4] Hence the need to find an international solution to this issue.

On the legal side, the International Law Association (ILA) adopted in 1994 a Draft Instrument for the Protection of Damage Caused by Space Debris. The Draft Instrument contains a definition of 'space debris', and explicitly makes states internationally *and strictly* liable for damage caused by 'space debris' originating from objects launched by them into space. A duty is imposed on states to cooperate in the implementation of the Draft Instrument and the reduction and control of 'space debris'. There is an obligation to negotiate 'in good faith' with other states to whom the proposed or foreseen production of space debris is of concern. A dispute resolution mechanism is also integrated into the Draft Instrument.

However, there has been little progress made in implementing the Draft Instrument into a binding international agreement. At least since 1995, attempts have been made by some States to have the issue included in the agenda of the LSC of COPUOS. These attempts have consistently failed to win a consensus.

While the drafting of a comprehensive international Convention to regulate space debris would be ideal, incorporating legal provisions (definitions, international responsibility, liability, registration, etc.) as well as technical rules (binding mitigation measures), the problem is so acute that a faster solution may be required. Given the consensus-based approach of COPUOS, and the difficulty involved in finding an acceptable compromise between the scientific and economic imperatives, the drafting of a new convention could take up to ten years, with no guarantee of success. Lafferranderie suggests a more pragmatic two-part approach, with the adoption of a set of principles on the broader issues (international responsibility, cooperation, liability, etc.), to 'complement the existing legal provisions', accompanied by the publication of a technical 'code of conduct' along the lines of the Mitigation Guidelines, which would be incorporated into national licensing regimes for space activities [24]. While such documents would lack binding force, the hope is that they would naturally lead to the drafting of international instruments [25], or through state practice crystallise into principles of customary international law.

The STSC has taken a positive step in this direction with the recent decision to produce a high-level space debris mitigation document, with completion scheduled in 2007. Now that the STSC has substantially finished its investigation of the technical issues involved, it is important for the LSC to take up the issue. Legal action is required sooner rather than later to preserve the astronomical sky, and indeed Earth orbit, for the use of future generations.

4. The relationship between space law and basic space science—a question of prioritisation?

The above discussion has shown how provisions in the existing space law corpus can affect the conduct of basic space science in various ways; however, the points of application are ad hoc, drawing on discrete, specific provisions, rather than stemming from a broader, identifiable doctrine of 'protection of space science'. Space law and basic space science intersect only tangentially because there is no explicit hierarchy of space activities in space law. At the time of drafting of the outer space treaties, the overriding belief was that there was room for all possible space applications to coexist [14, p. 110]. With the realisation that certain aspects of outer space, for example radio spectrum, are indeed scarce resources, one becomes compelled to make a value judgment in allocating those resources between various space applications [20]. The only question is whether this value judgment is made explicitly or implicitly.

At present, the most significant space applications are undoubtedly civilian and military telecommunications, remote Earth sensing, location and positioning systems and meteorological satellites. It could well be argued that these infrastructures are of vital use to the 'international community' [14], and that priority should be given to them in the allocation of resources (radio spectrum, orbital slots). In the current system this has been achieved *de facto*, through the spectrum allocation practices of the ITU,[5] without great debate. Where does basic space science fit into this prioritisation regime? How can astronomers and space scientists compete with such enormous commercial and military interests?

Hope may lie within the text of the Outer Space Treaty itself. Article I specifically guarantees freedom of scientific investigation in outer space. The problem is that this provision has generally been regarded as a statement of principle rather than one laying down concrete obligations

[4]Reference [15, p. 105]. Although it must be pointed out that some countries have voluntarily undertaken debris mitigation measures– for example NASA's 2003 'Policy for Limiting Orbital Debris Generation'. France and India have also recently de- or re-orbited satellites for this purpose; Ref. [23].

[5]Ref. [20]. Military communications are even accorded absolute priority, exempted from co-ordination entirely.

[5, p. 252]. If basic space science is to receive protection through some sort of prioritisation, then perhaps this could be achieved through reinforcement of Art I by means of a General Assembly Resolution (similar to the Principles on the use of Nuclear Power Sources in Space and the Declaration on International Cooperation) [26]. Such a resolution would be drafted by the LSC. The resolution would recite the historic and ongoing importance of space science in space exploration. It could recount the particular relevance of space science to developing countries as a gateway to national space activities, and encourage international cooperation to assist in these endeavours. It could reiterate that states are free to conduct activities in outer space, but encourage them to consider the effects of national space activities on the conduct of space science and to avoid harmful interference wherever possible.[6] The resolution could also refer to the need for radio spectrum reservation in favour of basic space science, and encourage the establishment of RQZs.

The above suggestion is reliant on the political will of states parties to recognise basic space science as being of importance to the international community. This is by no means certain, given the low profile space science enjoys in comparison to the 'big-ticket' space items such as communications and global navigation satellite systems. Thus it remains the task of space scientists worldwide to advertise the benefits of their work, to provide an impetus for substantive legal reform. This could occur, inter alia, through formal mechanisms such as COPUOS [26, p. 145], and informal forums such as international conferences. There have been numerous proposals made for education and outreach activities to inform decision makers, as well as the general public, of the significance of basic space science [36, pp. 343–392]. The challenge is to break down the esoteric, 'ivory-tower' image and emphasise the importance of astronomy and basic space science in increasing our understanding of the world around us [28]. These areas have always been at the forefront of human wonder and philosophical thought, and hence of immense *cultural* value [29].

It is important to note that progress is being made. The Unispace III conference report made note of the central role of space science in contributing to the 'future well-being of humanity' [9, p. 47], as well as declaring that harmful interference with space science should be minimised wherever possible. COPUOS has undertaken discussions on space advertising and space debris. The efforts of space scientists to draw attention to their needs are being noticed slowly, if not spectacularly.

On a broader level, efforts have been underway to draft an instrument on the ethics of outer space, for submission to the 33rd General Conference of UNESCO in 2005. The draft document, based on the recommendations of the Commission on the Ethics of Scientific Knowledge and Technology (COMEST) and the report of the Rapporteur of the former COMEST sub-commission on the ethics of outer space, aims to identify ethical (that is moral, as opposed to legal) issues related to the use and exploration of outer space. It is important to take ethical considerations into account because of the anthropocentric nature of outer space law. The interests of all nations and the maintenance of international security are at the focal point of the space law regime [30].

The draft document refers to the freedom of scientific exploration, as declared in the Outer Space Treaty, as an underlying ethical principle that should guide the practice of states [31, [1.3.7]]. Furthermore, scientific data should be freely accessible by researchers and university staff in every country [31, [1.3.5]], while commercial data may be protected according to 'commercial logic' [31]. States would be encouraged to take 'all appropriate measures' to give effect to these principles [31, [1.4.1]]. This could include the publication of scientific data obtained from space experiments as quickly as possible on the internet.

The draft document draws our attention to a fundamental question of space use and exploration. Is the primary motivation the advancement of scientific knowledge, is it conquest, is it resource exploitation? [31, [3.1]] Space exploration has been marked by the extreme dynamism with which the interests of states and private enterprises have shifted since the launch of Sputnik I [32]. Few would contest that space exploration offers unparalleled promise to make a positive impact on everyday lives. The key is to avoid repeating the mistakes of the past, allowing the 'greater good' to be obscured by the 'distortions and destruction' generated by the 'unbalanced relation among private, state and public interests' [32, p. 59]. Perhaps it is only by adopting a value-oriented normative framework, with ethical considerations at the forefront, that the interests of 'humankind' as a whole can be served [32, p. 65]. Science and ethics are closely related, and scientists should advance the argument that a 'just' priority of interests must recognise and protect the interests of science for the betterment of humankind.

In this context, developing nations can play an important role. As discussed, basic space science has often served as a driving force behind national space programmes. The UN/ESA workshop series on basic space science has identified a three-stage process known as 'Tripod' for the accelerated implementation of basic space science activities [33]. The acquisition of a research infrastructure allowing the taking of meaningful scientific data is the first step towards the establishment of an indigenous space science capability. The *Declaration on International Cooperation* specifically mentions the need for technical assistance in promoting the development of space science and space capabilities in interested states [34], which could be of assistance to developing countries in attaining the critical mass required for such endeavours. It is in the interests of developing countries with space aspirations to advocate law reform protecting astronomical

[6] A useful definition of 'basic space science' that could be used in a GA resolution is found in Ref. [27].

observations, in order to ensure that this crucial impetus is not lost. Such considerations are of importance to space science lobbyists, who need to find national delegates to represent their view in international forum such as COPUOS [8, p. 18].

Finally, attention should be drawn to the forthcoming International Heliophysical Year in 2007. Preparations are gathering momentum, with plans to involve scientists from some 191 member states in an unparalleled display of international collaboration. IHY 2007 celebrates the 50th anniversary of the International Geophysical Year (IGY 1957) which was a major driving force behind humankind's first foray into space. IHY is an invitation to COPUOS and its subsidiary bodies to look back 50 years at what has been achieved by COPUOS in terms of space science, space technology and space law. IHY 2007 will provide space scientists with a perfect forum to demonstrate the 'beauty, relevance and significance of space and earth science to the world' and the contribution that space science can make to our (terrestrial) community [35]. By chance, the Outer Space Treaty will also celebrate its 40th anniversary in 2007. One hopes that space scientists are able to use the conjunction of twin anniversaries to bring about positive law reform.

5. Conclusion

Scientific exploration has always been of importance to space exploration, and space law contains specific reference to the needs of science, most notably through Article I of the Outer Space Treaty. However, legal developments in the next 5–10 years will be critical for the future of astronomy and basic space science. With the increasing commercialisation of the space industry, the interests of space scientists will require protection through legal instruments. Their interests are to a certain extent incompatible with those of commercial space enterprises. This paper has identified two particular areas where urgent reform is needed. The international community is aware of these problems, and the United Nations has specifically recognised them through discussions in COPUOS and Unispace III.

In the longer term, it has been suggested that a General Assembly Resolution be adopted which expands on Article I, and explicitly recognises the importance of basic space science and the need to protect it from competing commercial applications.

It lies with the scientific community to press the case for increased recognition of space science. This paper has discussed the legal, practical, cultural and ethical arguments that could be of assistance in attaining law reform. Space science has made crucial contributions to the advancement of human thought and scientists must not allow their work to be dismissed as esoterica. IHY 2007 will provide a showcase for progress in space science. It is to be hoped that space scientists' quiet but persistent efforts will lead to substantive law reform, allowing future generations to enjoy the intellectual and practical benefits of their work. With patience, understanding and cooperation, surely space is large enough to allow science and commerce to co-exist.

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